

Claims:

- 1 1. An optical switch, comprising:
 - 2 a plurality of transmitting devices integrated on a single
 - 3 substrate, each of an individual transmitting device including a
 - 4 directing device;
 - 5 a plurality of receiving devices,
 - 6 wherein at least a portion of the transmitting devices
 - 7 direct output beams from the plurality of transmitting devices to
 - 8 the plurality of receiving devices.
- 1 2. The switch of claim 1, wherein the plurality of
- 2 transmitting devices are integrated on a single substrate in a
- 3 batch process.
- 1 3. The switch of claim 1, wherein the plurality of
- 2 transmitting devices includes a plurality of focusing devices,
- 3 each of an optical fiber from the plurality of transmitting devices
- 4 being coupled to at least one focusing device.
- 1 4. The switch of claim 1, wherein the plurality of
- 2 transmitting devices includes a plurality of directing devices,
- 3 each of an optical fiber of the plurality of transmitting devices
- 4 being coupled to at least one directing device.
- 1 5. The switch of claim 1, wherein the plurality of
- 2 transmitting devices includes a plurality of focusing devices and
- 3 a plurality of directing devices, wherein each of a focusing
- 4 device is coupled to a directing device.
- 1 6. The switch of claim 3, wherein each focusing device
- 2 includes at least one lens.
- 1 7. The switch of claim 5, wherein each lens is selected
- 2 from a regular lens, a GRIN lens, a diffractive grated lens, and a
- 3 Fresnel lens.

1 8. The switch of claim 3, wherein at least a portion of
2 the focusing devices include a micro-collimator.

1 9. The switch of claim 3, wherein at least a portion of
2 the focusing devices include an optical waveguide.

1 10. The switch of claim 3, wherein at least a portion of
2 the focusing devices include a variable-focus lens.

1 11. The switch of claim 4, wherein each directing device
2 is a micro-mechanical device.

1 12. The switch of claim 4, wherein at least a portion of
2 the directing devices include an optical waveguide.

1 13. The switch of claim 11, wherein each micro-
2 mechanical device includes an actuator.

1 14. The switch of claim 13, wherein each actuator is
2 selected from an electro-static actuator, an electromagnetic
3 actuator, a piezoelectric actuator, a thermo-mechanical actuator
4 and a polymer actuator.

1 15. The switch of claim 14, wherein the polymer
2 actuator is an electro-active polymer actuator, an optical-active
3 polymer actuator, a chemically active polymer actuator, a
4 magneto-active polymer actuator, an acousto-active polymer
5 actuator and a thermally active polymer actuator.

1 16. The switch of claim 11, wherein each micro-
2 mechanical device includes a suspension member that provides
3 movement of a distal portion of an optical fiber of the plurality of
4 transmitting optical fibers.

1 17. The switch of claim 16, wherein each suspension
2 member includes at least one elastic deformation member that
3 provides a mechanical coupling between a substrate and the
4 movable part of the directing device.

1 18. The switch of claim 3, further comprising:
2 an optical body positioned between each focusing device
3 and a distal end of each of a optical fiber of the plurality of
4 transmitting optical fibers.

1 19. The switch of claim 18, wherein the optical body
2 includes at least one of a solid optical transparent material, a
3 liquid optically transparent material, a gaseous optically
4 transparent material, a gel optically transparent material.

1 20. The switch of claim 1, wherein at least a portion of
2 the receiving devices are directed to receive the transmitter
3 output beams from the plurality of transmitting devices while
4 simultaneously focusing the incoming beams into the plurality
5 of optical fibers of the plurality of receiving devices.

1 21. The switch of claim 1, wherein the plurality of
2 receiving devices includes a plurality of focusing devices, each of
3 an optical fiber of a plurality of receiving optical devices being
4 coupled to at least one focusing device.

1 22. The switch of claim 1, wherein the plurality of
2 receiving devices includes a plurality of directing devices, each
3 of an optical fiber of a plurality of receiving optical devices being
4 coupled to at least one directing device.

1 23. The switch of claim 1, wherein the plurality of
2 receiving devices includes a plurality of focusing devices and a
3 plurality of directing devices, wherein each of a focusing device
4 is coupled to a directing device.

1 24. The switch of claim 21, wherein each focusing
2 device includes at least one lens.

1 25. The switch of claim 21, wherein at least a portion of
2 focusing devices include a micro-collimator.

1 26. The switch of claim 21, wherein at least a portion of
2 the focusing devices include an optical waveguide.

1 27. The switch of claim 21, wherein at least a portion of
2 focusing devices include a variable-focus lenses.

1 28. The switch of claim 24, wherein each lens is
2 selected from a regular lens, a GRIN lens, a diffractive grated
3 lens, and a Fresnel lens.

1 29. The switch of claim 22, wherein each directing
2 device is an micro-mechanical device.

1 30. The switch of claim 22, wherein at least a portion of
2 the directing devices include an optical waveguide.

1 31. The switch of claim 29, wherein each micro-
2 mechanical device includes an actuator.

1 32. The switch of claim 31, wherein each actuator is
2 selected from an electro-static actuator, an electromagnetic
3 actuator, a piezoelectric actuator, a thermo-mechanical actuator
4 and a polymer actuator.

1 33. The switch of claim 32, wherein the polymer
2 actuator is an electro-active polymer actuator, an optical-active
3 polymer actuator, a chemically active polymer actuator, a
4 magneto-active polymer actuator, an acousto-active polymer
5 actuator and a thermally active polymer actuator.

1 34. The switch of claim 29, wherein each micro-
2 mechanical device includes a suspension member that provides
3 movement of a distal portion of a transmitting optical fiber of
4 the plurality of transmitting optical fibers.

1 35. The switch of claim 34, wherein each suspension
2 member includes at least one elastic deformation member that

3 provides a mechanical coupling between a substrate and at
4 least a portion of each micro-mechanical device.

1 36. The switch of claim 21, further comprising:
2 an optical body positioned between each focusing device
3 and a distal end of each optical fiber of the plurality of receiving
4 devices. .

1 37. The switch of claim 36, wherein the optical body
2 includes at least one of a solid optical transparent material, a
3 liquid optically transparent material, a gaseous optically
4 transparent material, a gel optically transparent material.

1 38. The switch of claim 1, wherein at least a portion of
2 transmitting devices are MEMS devices.

1 39. The switch of claim 3, wherein at least a portion of
2 focusing devices are MEMS devices.

1 40. The switch of claim 4, wherein at least a portion of
2 directing devices are MEMS devices.

1 41. The switch of claim 21, wherein at least a portion of
2 focusing devices are MEMS devices.

1 42. The switch of claim 22, wherein at least a portion of
2 directing devices are MEMS devices.

1 43. The switch of claim 24, wherein at least a portion of
2 lenses are MEMS devices.

1 44. The switch of claim 1, wherein each of a
2 transmitting device includes a fiber placement cavity.

1 45. The switch of claim 1, further comprising at least
2 one transmitter substrate with a plurality of fiber placement
3 cavities, each of a fiber placement cavity corresponding to a
4 transmitting device of the plurality of transmitting devices.

1 46. The switch of claim 45, further comprising at least
2 one receiver substrate with a plurality of fiber placement
3 cavities, each of a fiber placement cavity corresponding to a
4 receiving device of the plurality of receiving devices.

1 47. The switch of claim 46, wherein each of a
2 transmitter device includes a focusing device and a directing
3 device positioned adjacent to a fiber placement cavity.

1 48. The switch of claim 47, wherein each of a receiver
2 device includes a focusing device and a directing device
3 positioned adjacent to a fiber placement cavity.

1 49. The switch of claim 45, wherein each of a
2 transmitter device includes a focusing device and a directing
3 device at least partially positioned in a fiber placement cavity.

1 50. The switch of claim 49, wherein each of a receiver
2 device includes a focusing devices and a directing device at least
3 partially positioned in a fiber placement cavity.

1 51. The switch of claim 48, wherein each directing
2 device includes a suspension member that provides movement
3 of a distal portion of a transmitting or receiving optical fiber.

1 52. The switch of claim 50, wherein each directing
2 device includes a suspension member that provides movement
3 of a distal portion of a transmitting or receiving optical fiber.

1 53. The switch of claim 1, further comprising:
2 a first substrate coupled to the plurality of transmitting
3 devices that include a plurality of transmitting optical fibers, a
4 plurality of focusing members and a plurality of directing
5 members;

6 a second substrate coupled to the plurality of receiving
7 devices that include a plurality of receiving optical fibers, a

8 plurality of focusing members and a plurality of directing
9 members.

1 54. The switch of claim 53, wherein at least a portion of
2 the receiving devices are directed to receive the transmitter
3 output beams from the plurality of transmitting devices while
4 simultaneously focusing the incoming beams into the plurality
5 of optical fibers of the plurality of receiving devices.

1 55. The switch of claim 53, wherein the first and second
2 substrates each include a plurality of fiber placement cavities. .

1 56. The switch of claim 55, wherein a cross-sectional
2 dimension of a fiber placement cavity is greater than the size of
3 the components positioned in the cavity. .

1 57. The switch of claim 53, wherein the plurality of
2 transmitting devices includes a plurality of elastic deformation
3 members that provide a mechanical coupling between the first
4 substrate and a movable parts of directing devices.

1 58. The switch of claim 53, wherein the plurality of
2 receiving devices includes a plurality of elastic deformation
3 members that provide a mechanical coupling between the
4 second substrate and a movable parts of directing devices.

1 59. The switch of claim 1, further comprising
2 an optically transparent media between transmitting and
3 receiving devices where light beams from said transmitting
4 devices can mutually intersect on their way to corresponding
5 receiving devices.

1 60. The switch of claim 59, wherein the optically
2 transparent media includes a vacuum, a solid optically
3 transparent material, a liquid optically transparent material, a

4 gaseous optically transparent material, a gel optically
5 transparent material.

1 61. The switch of claim 59, wherein optically
2 transparent media is a system of lenses between transmitting
3 and receiving devices.

1 62. The switch of claim 61, wherein each lens is
2 selected from a regular lens, a GRIN lens, a diffractive grated
3 lens, and a Fresnel lens.

1 63. The switch of claim 1, wherein a number of
2 transmitting devices and a number of receiving devices are the
3 same.

1 64. The switch of claim 1, further comprising:
2 a control system coupled to the plurality of transmitting
3 devices and plurality of receiving devices, the control system
4 providing control signals that coordinate positioning of
5 transmitting devices and receiving devices.

1 65. The switch of claim 1, further comprising:
2 at least one sensor coupled to the plurality of transmitting
3 devices and the control system; and
4 at least one sensor coupled to the plurality of receiving
5 devices and the control system.

1 66. The switch of claim 65, wherein each of the
2 plurality of transmitting and receiving devices includes at least
3 one photosensitive sensor.

1 67. A method for optical switching between input fiber
2 channels output fiber channels comprising:
3 providing a plurality of transmitting devices including a
4 plurality of optical fibers and a plurality of receiving devices

5 including a plurality of optical fibers, the plurality of
6 transmitting devices being integrated on a single substrate; and
7 focusing and directing at least a portion of the transmitter
8 output beams from the plurality of transmitting devices to the
9 plurality of receiving devices.

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